MOSTEK

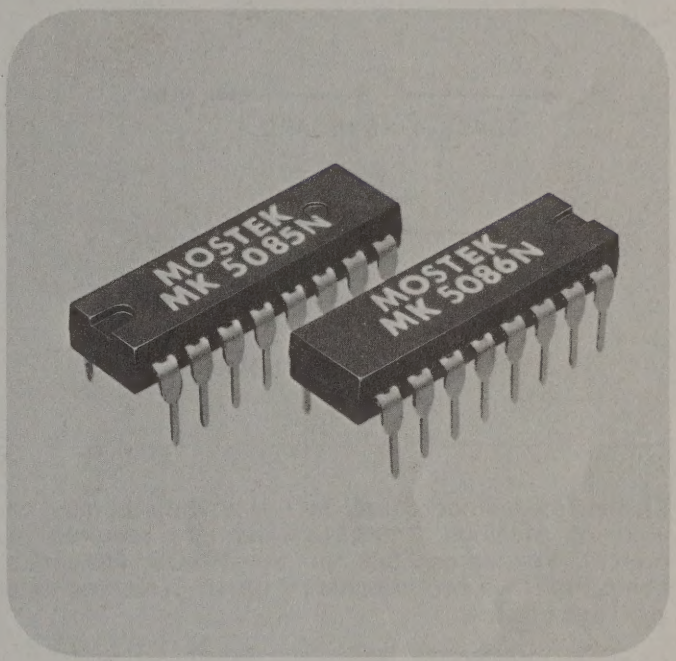
INTEGRATED TONE DIALER

MK5085N / MK5086N

April 1976

FEATURES

- ☐ Direct telephone line operation with no external power supply
- ☐ Requires minimal telephone line tone interfacing
- ☐ High Accuracy tones
- ☐ Digital divider logic, resistive ladder network and CMOS operational amplifier on single chip
- ☐ Uses inexpensive 3.579 MHz crystal
- ☐ Wide DC supply Voltage range
- ☐ Invalid key entry can result in either single tone or no tone
- ☐ MK 5085 designed for use with calculatior type (Class A contact) keyboards
- ☐ MK 5086 designed for use in applications requiring minimal electronic interfacing
- ☐ Both parts will work in existing telephone keypads
- ☐ May use high impedance keyboard switches
- ☐ Telephone common functions on chip



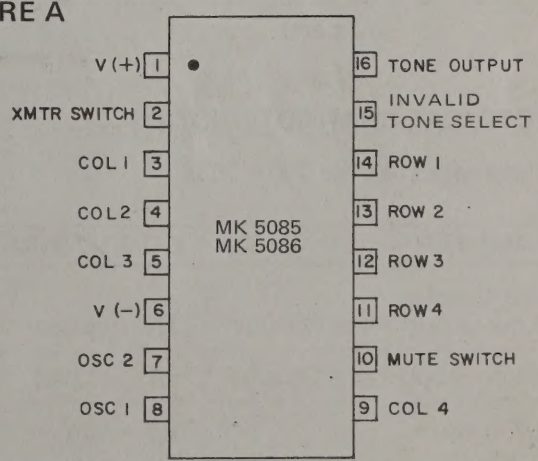
DESCRIPTION

The MK 5085 and MK 5086 are monolithic integrated circuits fabricated with the complementary-symmetary MOS (CMOS) process. Using an inexpensive crystal reference, the MK 5085/86 provide eight different audio sinusoidal frequencies, which are mixed together to provide tones suitable for Dual-Tone Multi-Frequency (DTMF) telephone dialing.

The keyboard entries select the proper digital dividers to divide the 3.579MHz to obtain the unique audio frequencies required. These digital signals are then processed by a conventional R–2R ladder network, and current to voltage transformation is made by an on chip amplifier. This is a conventional D to A converter and yields sine waves of sufficient purity that little or no filtering is required. The same amplifier accomplishes summing of the low and high group tones to obtain the required dual tone signal. Frequency accuracy of the network is obtained via the crystal reference. This eliminates any need for frequency adjustment to the network.

The 5085/86 are primarily intended to be used in telephone applications, where they derive their power directly from the telephone lines and send the output tones back differentially across these lines. However, they may also be used with a fixed D.C. supply, and in this case, the audio output tones are available single ended from the output amplifier. The CMOS processing allows operation over a wide range of operating voltages, which implies proper operation over a wide range of loop resistance or a separate supply.

PIN CONNECTIONS
FIGURE A



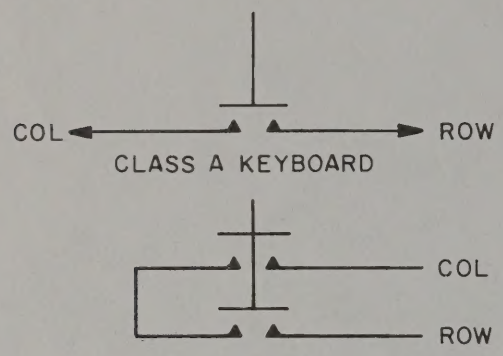
DESCRIPTION (cont'd)

The row and column information may be supplied to the MK 5085 via the 2 of 7 or 2 of 8 DTMF keyboard used in current telephones, when the key common is not tied to V+, or by using the class A keyboard such as those used on calculators.

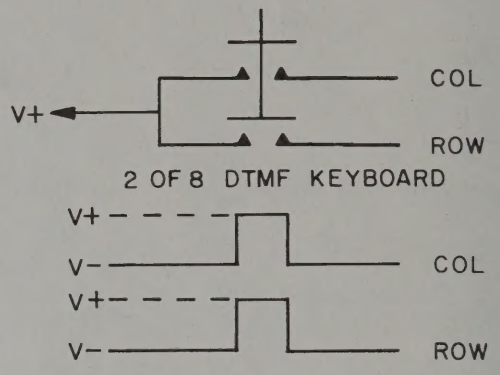
The MK 5086 operates by sensing V+ on the column and row pins which are being addressed. This is the scheme which is currently used in the existing L–C tone generators and lends itself to applications whereby the inputs can be provided by electrical appraratus such as microprocessors.

A schematic description of each keyboard for both parts is given below:

KEYBOARD CONFIGURATION
FIGURE B



2 OF 8 DTMF KEYBOARD
MK 5085



MACHINE ADDRESSED INPUT
MK 5086

The switch contacts used in the keyboards may be void of precious metals, which are required in present keyboards, due to the CMOS network's ability to recognize resistance up to 1 Kohms as a valid key closure.

The MK 5085 and MK 5086 are sorted into two catagories. The MK 5085-1 and MK 5086-1 will work for power supply ranges of 3.5 volts to 10 volts while the MK 5085-2 and MK 5086-2 work for power supplies of 4.5 volts to 10 volts.

ABSOLUTE MAXIMUM RATINGS

DC Supply Voltage ..... 10 Volts

Operating Temperature ..... –10°C to 60°C

Storage Temperature ..... –55°C to 150°C

Maximum Circuit Power Dissipation ..... 500 mW

RECOMMENDED OPERATING CONDITIONS $-10°C \leqslant T_A \leqslant 60°C$

Supply Voltage (–1 part) ..... 3.5V min, 10V max

(–2 part) ..... 4.5V min, 10V max

ELECTRICAL CHARACTERISTICS ..... $-10°C \leqslant T_A \leqslant 60°C$

All Parameters are for $T_A = 25°C$

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage Low Group Tone Output	1K Ω Load	360	450	540	mv RMS
High Group Tone Output	1K Ω Load	510	640	770	mv RMS
Tone Output	V+ = Min	750			Ω
External Load Impedence	V+ = Max	400			Ω

PARAMETER (cont'd)	CONDITIONS	MIN	TYP	MAX	UNITS
Output Current Drive Transmitter Switch	V+ = 3.5V V_{OUT} = 2.5V (–1 only)	20	30		MA
	V+ = 4.5V V_{OUT} = 3.5V (–2 only)	15	25		
	V+ = 10.0V V_{OUT} = 8.0V (–1 only)	80	100		MA
	V+ = 10.0V V_{OUT} = 8.0V (–2 only)	50	80		
Mute Switch	V+ = 3.5V V_{OUT} = 3.0V or 5V	150	250		
	V+ = 4.5V V_{OUT} = 4.0V or 5V	150	250		μA
	V+ = 10V V_{OUT} = 9.5V or 5V	500	700		
Standby Current (No Key Depressed)	V+ = 3.5V		200	1000	
	V+ = 4.5V		300	1500	μA
	V+ = 10.0V		750	3500	
Operating Current (Outputs Unloaded)	V+ = 3.5V		1.5	3.5	
	V+ = 4.5 V		2.5	5.5	MA
	V+ = 10.0V		9.0	20.0	
Keyboard Contact Resistance				1K	Ω
Maximum Keyboard Strobe Output Loading (Applies to 5085 only)				30	pf
Internal Input Resistance to V+ Supply (See R_R & R_C in Block Diagram)		20K	50K	100K	
MK 5086 Row and Column Input Switch Levels Logic 1		80	70		% of V+
Logic 0			30	20	
OSC Start Up Time External Crystal Load=10pf (Tone at 100% Level)			3	10	ms
Total Harmonic Distortion V+ = 3.8V (–1 part) V+ = 4.5V (–2 part)			6	10	%
Crystal Load Parallel External Capacitance = 10pf			12		pf

OSCILLATOR

The network contains an on board inverter with sufficient loop gain to provide oscillation when working with a low cost television "color burst" crystal. The inverter's input is OSC 2 (pin 7) and output is OSC 1 (pin 8). The circuit is designed to work with a crystal cut to 3.579545 megahertz to give the frequencies in Table 1.

CRYSTAL FREQUENCY TABLE 1

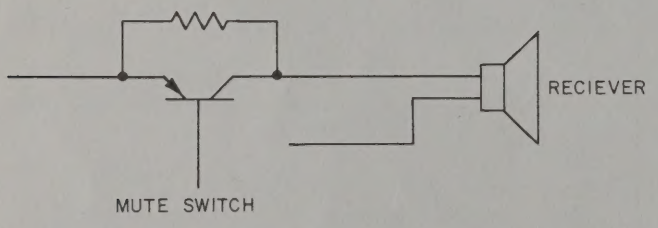
		Standard DTMF (Hz)	5085/6 Tone Output Frequency Using 3.579545 MHz Crystal	% Deviation From Standard	
ROW	f_1	697	699.1	+.31	LOW GROUP
	f_2	770	766.2	−.49	
	f_3	852	847.4	−.54	
	f_4	941	948.0	+.74	
COL	f_5	1209	1215.9	+.57	HIGH GROUP
	f_6	1336	1331.7	−.32	
	f_7	1477	1471.9	−.35	
	f_8	1633	1645.0	+.73	

Any crystal frequency deviation from 3.579545 MHz will be reflected in the Tone Output Frequency. Most crystals don't vary more than .02%. A 10 picofarad capacitor is required between the OSC 2 input and V+ or V− as well as a 10 megohm resistor across the crystal. Both of these components are shown in Figures F and G.

MUTE SWITCH (Pin 10)

The mute output is provided for applications which requires the receiver to be muted during the time that tones are generated. This output provides a signal which is normally at V− and goes to V+ whenever a keyboard entry is sensed by the MK 5085/6. The normal use of this output is to drive the base of a PNP transistor which is in parallel with a resistor. This circuit is in series with the receiver. The transistor is normally saturated and turns off when a tone is generated (See figure C).

RECEIVER MUTING FIGURE C



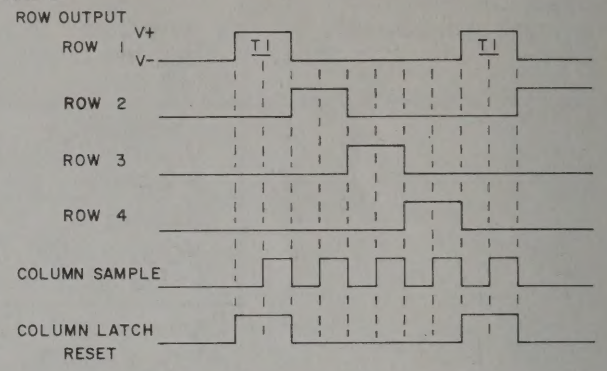
TIMING

In the MK 5085 a row is sensed when V+ on any column input is coincident with the detected row pulse. That row remains latched until the same row pulse reoccures.

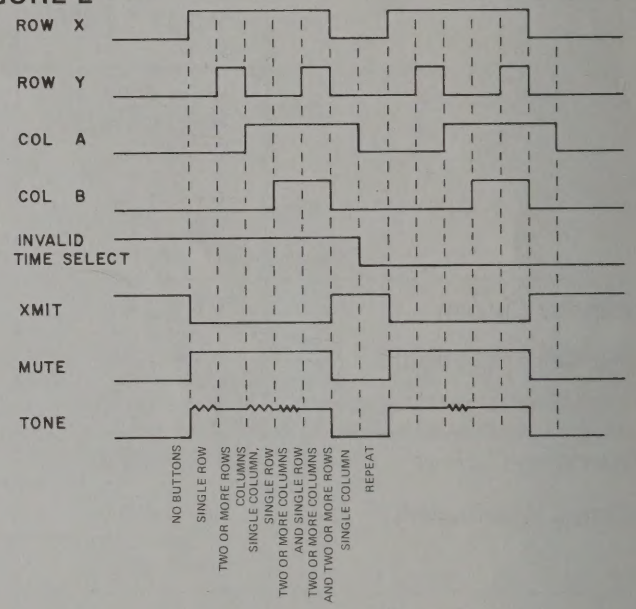
Columns are sensed when V+ is applied to any column during column sample time. That column remains latched until column latch reset strobe occurs.

All other timing is the same as the 5086.

MK 5085 TIMING FIGURE D



MK 5086 TIMING FIGURE E



INVALID TONE SELECT (ITS) (Pin 15)

Connecting the ITS pin to the supply V+ or leaving it floating (this pin has an internal pull-up to V+) will result in the following operation in the 5085/6.

5085 – A single key closure, i.e. a single row tied to a single column, will result in a dual tone consisting of that row and column. Multiple key closures will result in a single column tone in the case of 2 or more rows tied to that column, or a single row tone in the case of 2 or more columns tied to that row. If two or more rows are tied to two or more columns, no tone will be generated.

5086 –Connection of V+ to a single row will cause the generation of that row tone. Connection of V+ to more than one row will result in no tones being generated. The application of V+ to only a column pin or pins has no effect on the circuit. There must always be at least one row connected to V+ for column tones to be generated. If a single column tone is desired,

Installation Instructions for Motorola, Toshiba, Mitsubishi and similar RF Power Transistors and Modules

Please read these installation notes for RF Power Transistors & Modules. We have found that most failures in RF components can be traced to improper installation or tune-up procedures.

Module Mounting and Handling

(1) Before new part installation, clean all old thermal compound or contaminates from the heatsink. The surface should be smooth and clean, small burrs on mounting holes or bits of solder or metal will prevent proper heat transfer.
(2) Make sure there is adequate clearance between the components and the circuit board. Inadequate clearance may cause cover or substrate to crack or pop off transistor base.
(3) Spread a thin layer of fresh thermal joint compound on the new part. The compound provides heat conduction across otherwise small voids existing between the two surfaces. (An excessive amount of compound will actually reduce heat conductivity.) We recommend the compound "Thermalcote". (It is available from us and other electronics distributors.)
(4) Care should be taken to avoid dropping part onto a hard surface.

Soldering

(1) Solder leads to the circuit board. Avoid excessive bending of leads.
(2) The recommended solvent for cleaning the residual flux is Ethyl Alcohol.

Module Tune-up Tips

(1) Inspect the transmitter circuit before turn-on. As an example, in some VHF/UHF transceivers we have found defective PIN antenna switching diodes (as high as 20%). This indicates that a defective antenna may have caused the antenna switching circuit to fail, thus damaging the module. We suggest checking each diode in the switching circuit for leakage and high-forward/low-reverse resistance. This is easily done by lifting one end of diode under test and connecting a conventional analog Ohmmeter (X10 scale). Look for the usual high-reverse/low-forward resistance readings.
(2) Check the power control circuit for proper operation. PIN Diode failure may be caused by a leaky or insufficiently turned-on driver transistor. If any doubt, replace.
(3) To avoid damage to the new component during tune-up phase, the bias circuit should be checked for proper operation and setting.
(4) Initial test should be at low power; if all appears normal, proceed to next step.
(5) Refer to your equipment manual for power adjustment. As the new module may have higher gain than the original, you should reduce the drive level before high power test.
(6) Most modules will exceed the specified power rating. It is suggested, however, not to exceed the module or equipment rating as reliability rapidly decreases with increasing power.
(7) Should the new module fail in the transmitter, it would be reasonable to assume there is a problem remaining which has not been found, i.e.: (a) Intermittent antenna or cable; (b) Intermittently defective PIN diode or associated control circuit, cold solder joint, etc.; (c) Power setting above rated transmitter output.

Transistor Tune-up Tips

Matched Transistors are available from RF Parts Company. Transistors are selected into sets based on various criteria, including selection for low I_{cbo} leakage, uniform power gain and linearity, similar d.c. Beta, and normal curve-tracer readings. The RF Power Test does not represent maximum power, only an output measurement for a selected drive level. Example: We test each MRF454 in a test fixture at 3 watts input drive. The corresponding output is measured. A typical test output of 80 watts is about 75% of the transistor's peak capability. Transistors are then grouped by Beta & Power Gain. Thus, we are able to supply matched pairs, sets of 4, 8, 16, 32, etc., with very similar characteristics. You should save the transistor envelope, as it gives test information on the parts inside. In the event you are required to replace a transistor at a later time, you can order a similar replacement from the test data.
(1) Transistor installation is essentially the same as RF Power Modules. Care should be taken not to over tighten transistors having "studs", i.e. MRF1946A/MRF454A/MRF455A, etc., as the screw is made of copper.
(2) Transistors & RF Power Modules can be damaged by one or combination of the following factors: Excessive case temperature, excessive voltage or current, excessive drive power, oscillations in the circuit, excessive VSWR, etc.
(3) Some amplifiers are basically unstable and care should be taken to avoid excessive bias. Optimum bias voltage in CLASS AB_1 circuits is a collector current (at zero RF drive) less than 0.5% of the normal maximum collector current. Good linearity will be achieved without pushing the transistors into CLASS A (which often causes oscillation).
(4) The technician should first test at low power (low drive or low power setting on amplifier). You may increase drive power if the circuit remains stable and within normal current levels. When the power peak is reached, increased drive will not significantly increase output. At that point, output tuning should be adjusted to slightly less capacitance. Example, in a broad band amplifier, the tuning capacitor across the output winding should be set at slightly less capacitance than at peak power setting.
(5) MOS type parts require special care in regards to static electricity (similar to MOS IC's).

Limited Warranty Information

NOTICE: No exchange or warranty on transistors/modules which, in our opinion, have been damaged, installed, or used. Therefore, be sure the parts are proper for your equipment. Modules & transistors are fully tested under load and SWR by the factory to meet their specifications. The factory will not guarantee parts once installed.

If you have technical questions regarding installation or operation of products sold by RF parts Co., please feel free to call our Technical Department between the hours of 10:00 a.m. and 4:00 p.m. Pacific Time. The telephone number to call is (619) 744-0750.
Technical personnel are <u>not</u> available on our "800" order line.

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READ THIS BEFORE INSTALLING TUBES

Upon receipt, inspect all tubes to determine any shipping damage. If damaged, save box and all packing material. Contact the delivery service (UPS, etc.) to make claim. RF Parts cannot initiate a claim for shipping damage, you must contact delivery service directly. Do not send tubes to RF Parts. Only the delivery company can take care of the return.

Transmitting Tubes

(a) Eimac, Amperex, RFP (RF Parts Co.), Svetlana and similar power grid transmitting tubes carry the manufacturer's limited warranty against defective material and workmanship for 12 months or 3000 hours of operation.
(b) RF Parts Co. offers an extended limited warranty on its RFP PREMIUM 572B, 811A, and 3-500ZG tubes: 2 year/3000 hours against manufacturing defects when used in amateur service (first year full exchange/second year prorated).
(c) Svetlana tubes warranty varies from 1 year to 3 years depending on the tube type. Contact us regarding limited warranty on a particular tube.
(d) Tube problems resulting from improper operation, i.e. *excessive* operating temperature or power levels may void Manufacturer's Limited Warranty. These conditions are the responsibility of the equipment operator.
(#) denotes new tubes with older date codes, certified to be in new condition and carry a 90 day limited warranty against manufacturing defect.

Receiving & Special Purpose Tubes

(a) Before installation of new tubes, be sure the tubes supplied are the ***exact type required by your equipment.*** Some linear amplifiers need a particular brand or tube type in order to operate properly at full power.
(b) ***Once installed in equipment, tubes are considered used. Thus, cannot be returned for exchange.*** Damage to tubes from improper application cannot be covered by warranty.
(c) ***TV Sweep tubes*** (6JE6, 6KD6, 6KV6, 6LF6, 6LQ6, 6LX6, 6MJ6, 20LF6, 30KD6, 8950, M2057, etc.) are not designed rated, or warranted by manufacturer or RF Parts Co. for use in RF linear amplifier service. Therefore, care should be exercised to avoid premature failure. It is wise to operate sweep tubes at lower power to improve tube life.
(d) Special tubes used in amateur transceivers: 6146B, 6146W, 6JS6C, 6JB6, 12BY7 carry a 30-day limited warranty against factory defects.
(e) New tubes returned to RF Parts which are accepted for *credit* are subject to a 10% restocking charge to cover tube testing and handling procedures.

All tubes are factory tested to meet factory specifications. RF Parts Co. performs visual inspection for breakage, loose caps, loss of vacuum, etc., prior to shipment. We suggest all tubes be ordered in matched sets in an effort to equalize power sharing and stable operation. Matched tubes are selected for best performance, matching of Gm, plate current, etc. All possible care is taken to supply tubes in good condition. No further claim or warranty on receiving & special purpose tubes is offered or implied.

Notes:
(a) When replacing Japanese 6JS6C tubes in FT-101 transceivers with U.S. brand, it is necessary to replace the 100 pF series feedback capacitor with two 20 pF mica caps in series (equalling 10 pF/1KV) before neutralizing.
(Note: Series feedback capacitance required may be as large as 20 pF/1KV.)
(b) 6146B tubes of Chinese manufacture should be run at 75% rating.
(c) Consult equipment Owners Manual for tune-up and operating instructions to avoid possible tube damage. Abuse of all tubes, including evidence of excessive dissipation, plate melting, heat caused discoloration of surface, breakage or cracks in glass, and loss of emission due to excessive wear, are excluded from any limited warranty.

How to Return Tubes

Tubes to be returned for inspection must be handled in the following manner:
(1) Call Customer Service Dept. at (619) 744-0750 for return tracking number.
(2) Original Purchase Receipt must be included with tubes. No exceptions! (No original purchase receipt=No warranty.)
(3) A completed failure report form should be returned with power grid tubes.
(4) Tubes should be returned by prepaid United Parcel Service. Pack tubes carefully to assure safe delivery. Insure if necessary. Warranty coverage is not possible if tubes are received broken.

Allow 20 days at our plant for evaluation by our staff. *We will contact you with results of our inspection.* If it becomes necessary for us to forward tube to the manufacturer, please allow additional time for their evaluation. (Note: Eimac sometimes requires up to 6 weeks.) Any inquiries regarding warranty should be made directly to RF Parts Customer Service Department at (619) 744-0750, during the hours of 10 a.m.-4 p.m. Pacific Time (1 p.m.-7 p.m. Eastern Time). The Customer Service Dept. does not have an "800" number.

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INVALID TONE SELECT (cont'd)

it may be generated by tying any two row pins and the desired column pin to V+. Dual tones will be generated if a single row pin and a single column pin is connected to V+.

Connecting the ITS pin to the V–supply will allow the MK 5085/6 to generate only dual tones. Any input situation that would normally result in a single tone will now result in no tone output. The most common application of the ITS pin is in pay station telephones where single tone capability must be defeated.

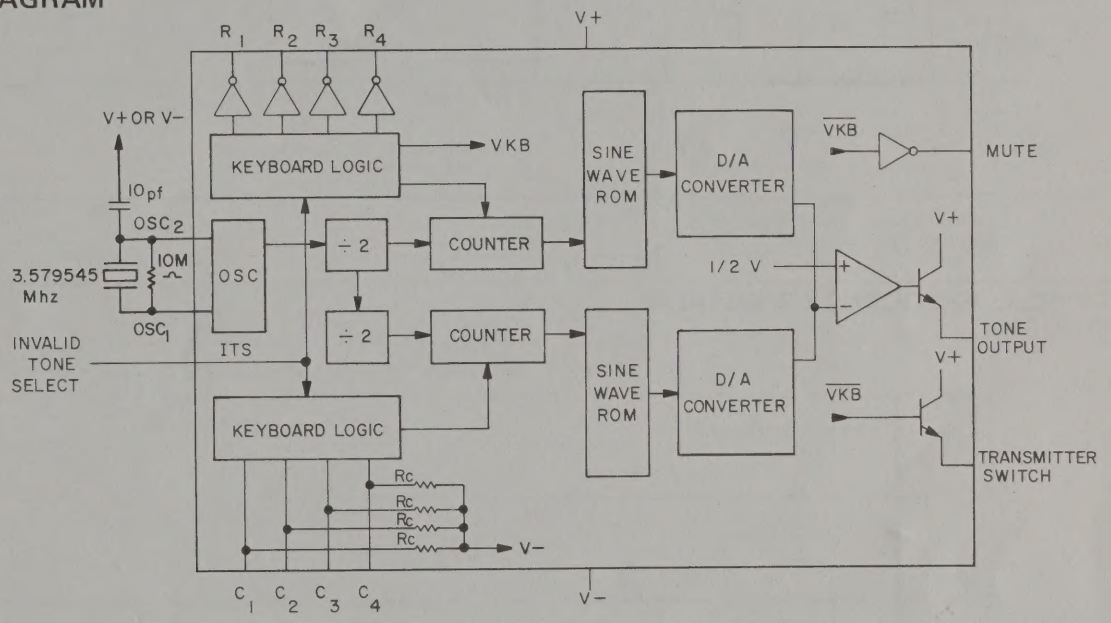
TRANSMITTER SWITCH (PIN 2)

The purpose of the transmitter switch output is to turn the transmitter off and on. It is connected internally in the MK 5085/6 to the emitter of an NPN transistor whose collector is tied to V+. This transistor is on when no keyboard entry is sensed. When a keyboard entry is sensed the pin is an open circuit. In telephone applications, this output is in series with the carbon microphone, and deactivates the microphone when keyboard buttons are pressed.

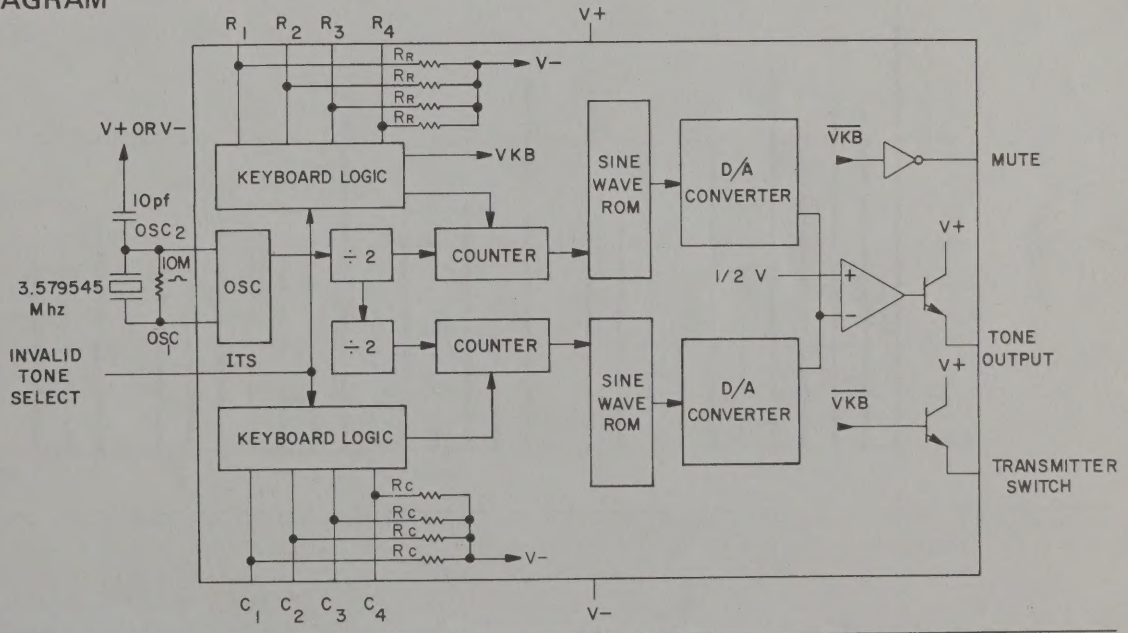
TONE OUTPUT (PIN 16)

The tone output pin is connected internally in the MK 5085/6 to the emitter of an NPN transistor whose collector is tied to V+. The input to this transistor is the on-chip operating amplifier which mixes the row and column tones together and provides output level regulation. The tone output pin is used to differentially drive the telephone line in pure telephone applications. In non-telephone applications, this pin may be used to drive 1000Ω load to the V– supply.

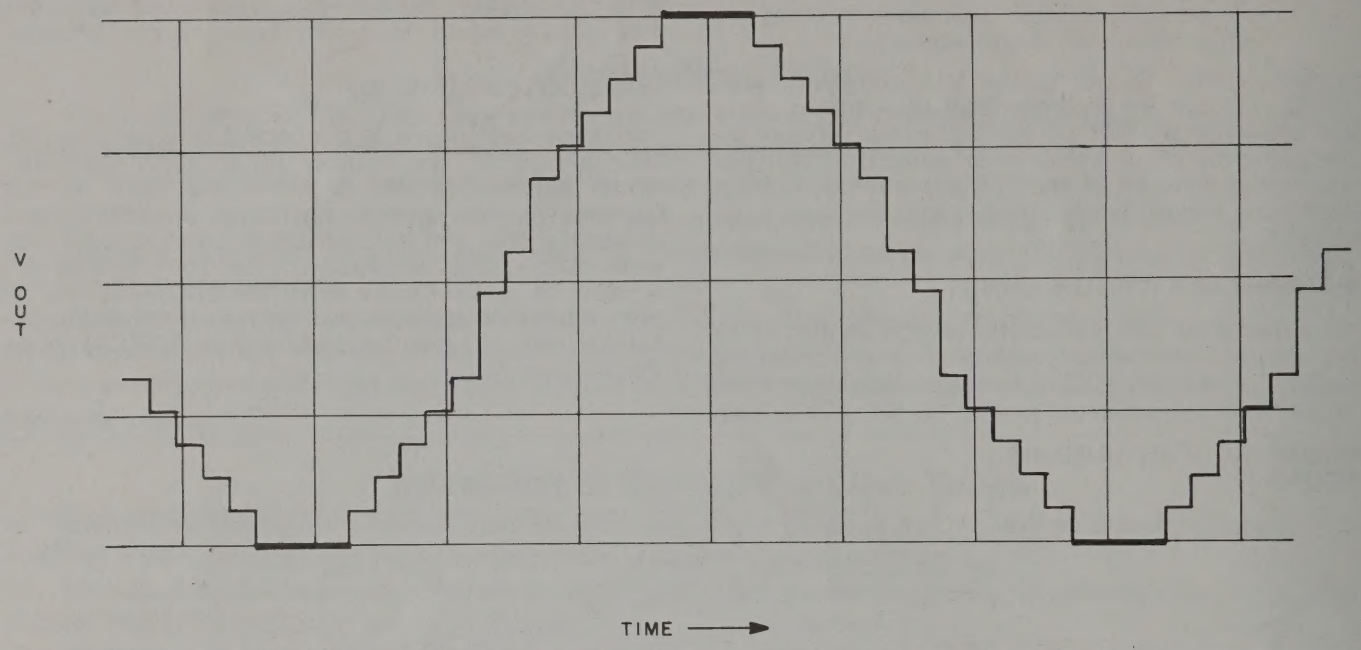
MK 5085 BLOCK DIAGRAM
FIGURE F



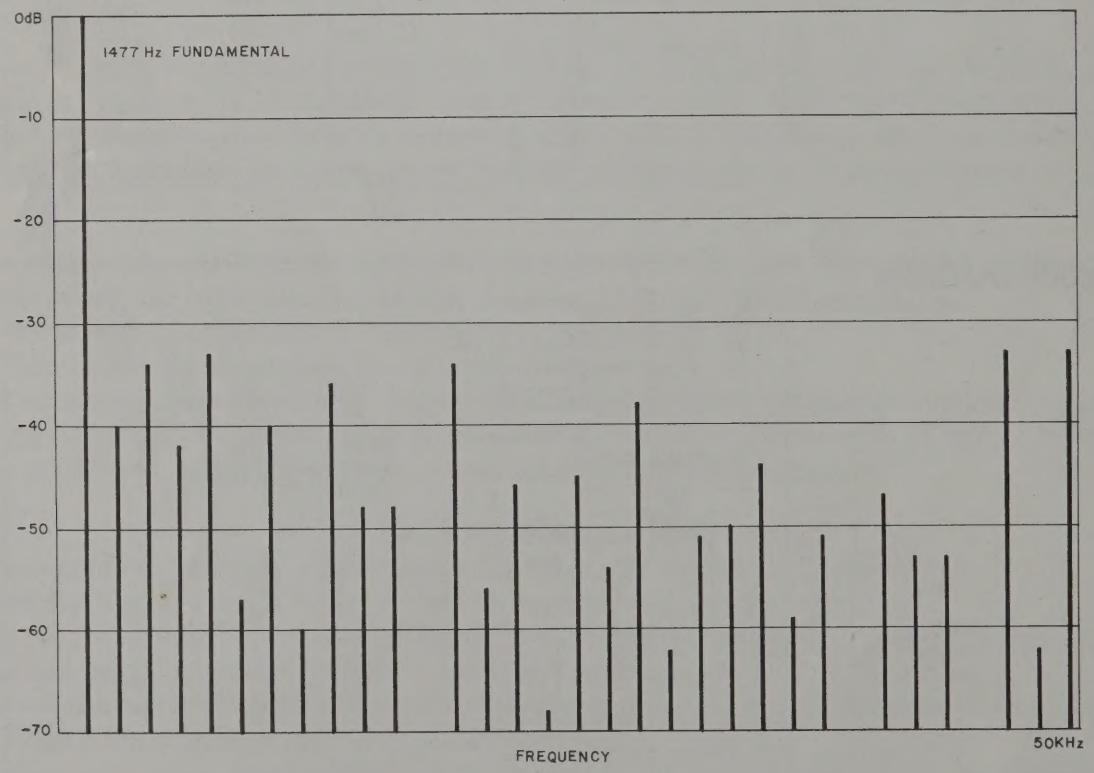
MK 5086 BLOCK DIAGRAM
FIGURE G



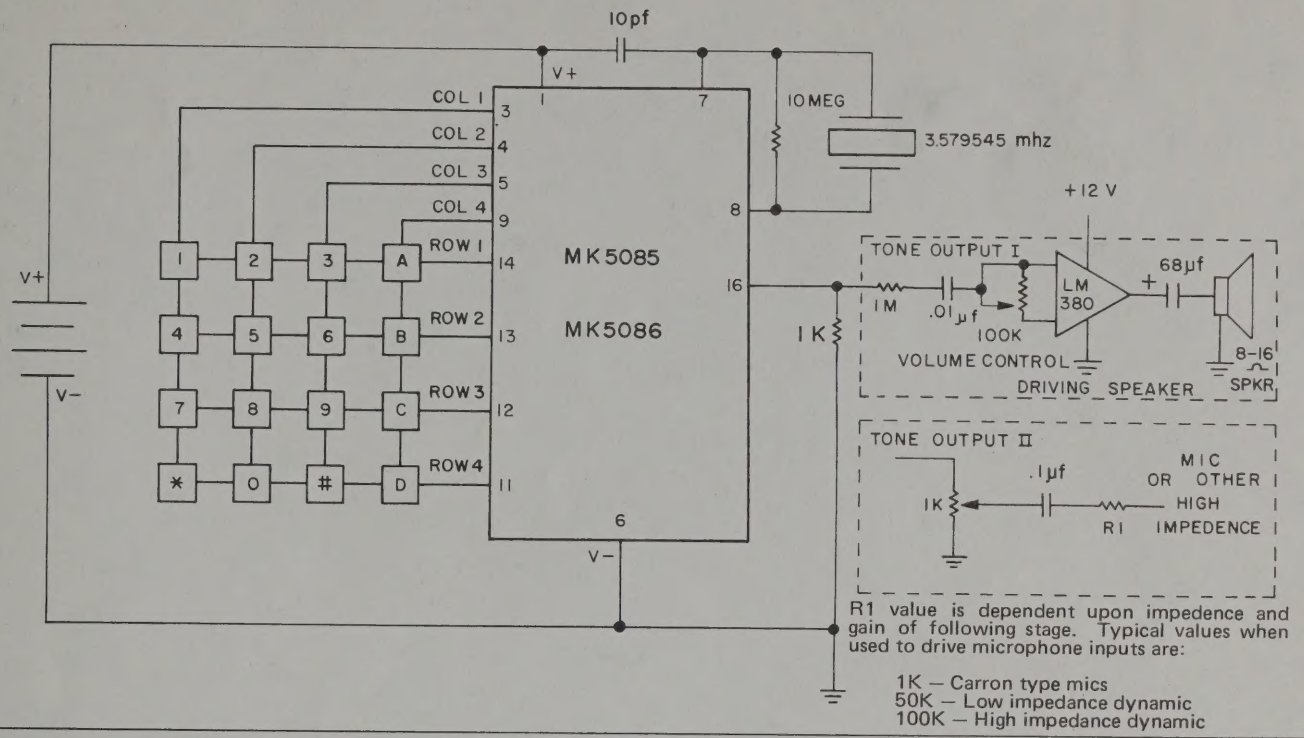
TYPICAL SINE WAVE OUTPUT
FIGURE H



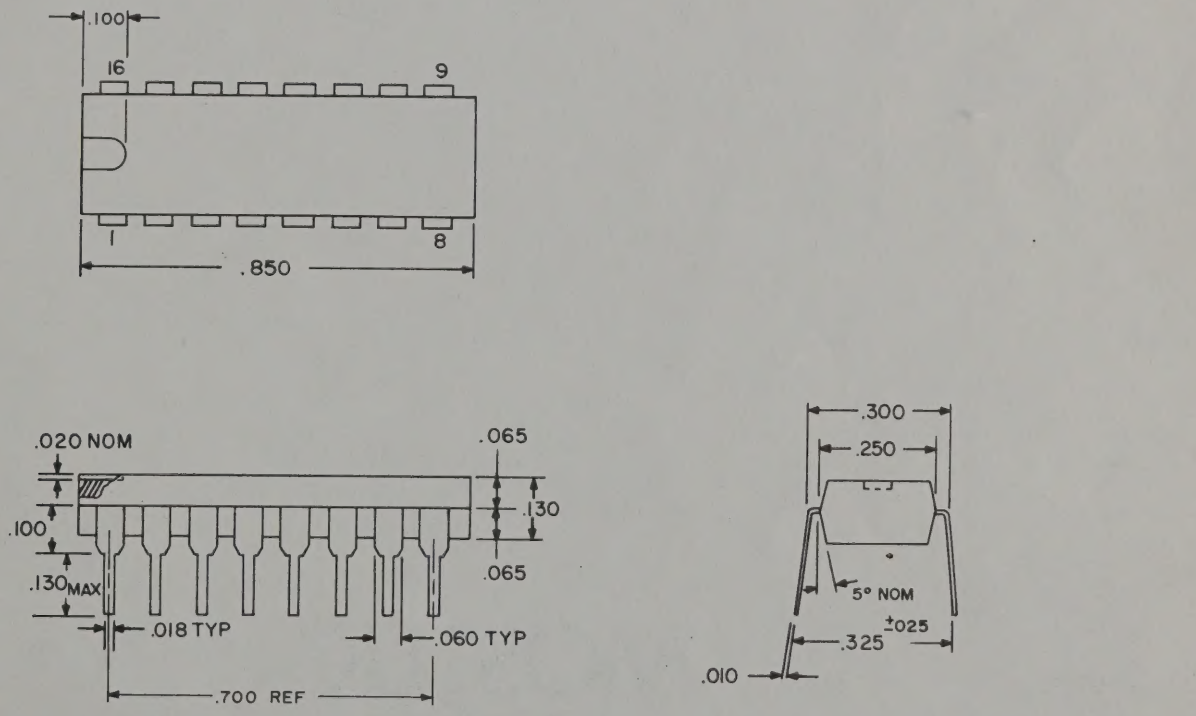
TYPICAL FREQUENCY SPECTRUM
FIGURE I



DTMF TONE GENERATOR - Fixed Supply Operation
FIGURE J



PACKAGE DESCRIPTION - 16 Pin Dual in-line Plastic Package
FIGURE K



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